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Evaluating the Impact of Weight Bearing and Non-Weight Bearing Exercises on Pain and Physical Function in Obese Knee Osteoarthritic Patients: A Randomized Controlled Trial

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Abstract

Background

Exercise is advised as a primary treatment for knee OA; however, the best exercise is still unknown among these patients with different comorbid like obesity. Hence, this trial was aimed to identify which regime is more suitable in patients with knee OA and obesity.

Methods

A randomized controlled trial conducted in Lahore, Pakistan, compared the effectiveness of two exercise regimens i.e. Group A: Weight-bearing functional exercise program and Group B: Quadriceps strengthening through non-weight bearing techniques in obese individuals aged 50 and above with painful medial knee OA. A total of 128 participants were randomly assigned to either group. They attended supervised sessions with a therapist 5 times/week for 12 weeks. Pain and physical function were measured as primary outcomes at baseline and after the intervention.

Results

The mean age of participants was 57±4.03, with 78 females and 50 males. The results revealed that outcomes were improved in both groups. However, Group B showed more significant results, with a mean of 3.92±0.9, whereas Group A results were also substantial, with a mean of 4.53±1.02. The findings were consistent for physical function, which improved more in Group B with a mean of 42.35±3.02 compared to Group A with a mean of 45.68±81.

Conclusion

Both groups showed significant improvement in both outcomes. However, participants in non-weight-bearing quadriceps strengthening show more statistically and clinically relevant results.

Keywords

Exercise, Obesity, Osteoarthritis, Pain, Physical Activity.

Introduction

Musculoskeletal health refers to the healthy operation of the body's locomotor system, including muscles, bones, joints, and the surrounding connective tissues. Over 150 diseases and conditions can affect this system, impairing a person's ability to function and participate in daily activities[1]. The prevalence of musculoskeletal disorders worldwide is alarming. Over 1.71 billion people are affected by musculoskeletal conditions worldwide, including rheumatoid arthritis, osteoarthritis, amputation, low back pain, neck pain, fractures, and other injuries[2]. Musculoskeletal disorders frequently coincide with other non-communicable diseases and heighten the likelihood of developing additional conditions, such as cardiovascular disease[3]. In addition, people who have musculoskeletal problems are more likely to have mental health issues[4].

Chronic pain and functional impairment are hallmarks of Knee Osteoarthritis (OA), a common and progressive multifactorial joint disease[5]. Knee OA is responsible for nearly 80% of the overall burden of OA worldwide, and its prevalence tends to rise with age and obesity[5]. A serious public health concern is knee OA, primarily affecting the medial tibiofemoral compartment[6]. Pain is a prominent feature of knee osteoarthritis and becomes increasingly persistent and restrictive as the disease advances, leading to diminished physical functioning and reduced quality of life[7]. Obesity is a known risk factor for the progression of the disease and is commonly found among people with osteoarthritis, among other risk factors[8].

Arthritis significantly impacts a person's personal, social, and financial life. Targeted and efficient conservative treatments are required for people at risk of the disease progressing, such as those with comorbid obesity, to lessen this burden. In all stages of OA, exercise therapy has been shown to reduce knee pain. The effect sizes for exercise therapy are small, possibly because randomized controlled trials have often utilized a generic exercise prescription, failing to tailor the treatment to the individual's clinical presentation, which has diminished the treatment's effectiveness[9]. A study was conducted in 2015 on obese OA patients comparing the effects of non-weight bearing quads strengthening and neuromuscular weight bearing. Both programs resulted in modest pain improvements, with a statistically insignificant difference. However,

exploratory post-hoc analyses showed that responses to the two exercise programs for people with obesity varied in terms of how much pain they could relieve[10]. These findings are not conclusive but suggestive of a hypothesis, implying that individuals with medial knee OA and obesity may need exercise programs tailored to their specific needs to optimize the outcomes. Patients who suffer from knee osteoarthritis and are obese may experience more significant improvements in pain reduction and improved physical capacity if they engage in a non-weight-bearing exercise program that places less strain on the knee joint, as opposed to a more demanding weight-bearing program that is mentally and physically challenging. The main goal of this randomized controlled trial is to compare the effects of two different home-based exercise regimens on pain relief and physical function in people with medial compartment knee osteoarthritis and obesity, specifically non-weight-bearing quadriceps strengthening and weight-bearing functional exercise.

Methodology

The study was a double-blinded, randomized, controlled design conducted at Physical Therapy Rehabilitation Centre in Lahore. Patients who suffer from medial knee osteoarthritis and are classified as obese with age ≥50 years were enrolled in the study. Patients were recruited by emailing existing research volunteers and displaying flyers and posters in medical clinics. Patients who had knee pain for ≥ 3 months, a body mass index ≥30 kg/m^2, and the presence of osteophytes on X-ray at tibiofemoral surfaces were included in the study. The study received ethical approval from the Institutional Review Board (PRC/IRB/018/2023). Voluntary participation was ensured by providing them with written informed consent in which brief detail of research with its potential benefits and harms was provided. Participants were assured that their information would be kept confidential. Patients and outcome assessors were blinded to the treatment group for data accuracy. Measurements were taken at baseline and after 12 weeks of intervention. Further, the participants visited the physiotherapist 5 times weekly with each session lasted 30-40 minutes. Participants continued their usual medication throughout the regime.

Interventional Strategies

Weight-Bearing Functional Exercise Program[11]

This program incorporates neuromuscular exercises that include sliding, sliding with thera-bands, stepping with thera-bands, and then sliding again with thera-bands. The objective was to increase the functional strength of lower extremity muscles, maintenance of joint alignment at the trunk and lower extremity, and quality of movement. The exercise was performed on a foam mat, an adjustable step of 10 to 15 cm length, and elastic resistance bands. Throughout the activities, participants were asked to keep their knees neutrally aligned (as much as possible with their knee over their foot) and to keep their pelvis and trunk aligned in the frontal plane.

Quadriceps Strengthening Through Non-Weight-Bearing Techniques[12]

The programme includes the following exercises: quads over a roll, knee extension while sitting, knee extension while holding at 300, straight leg raise, and short arc knee extension in a sitting or lying position. Adjustable ankle weight cuffs with a weight range of 0.65 Kgs up to 10 Kgs and thera-bands were given to the participants. For starting 2 weeks of the program, 2 sets of 10 repetitions with every 2 sets for each exercise were set and progressed to 3 sets/exercises after 3 weeks, or as soon as the participant could. The initial weight for strength training was determined by either participant's level of effort, which was set at 5 to 8 out of 10 (hard to very hard), 12 in some cases and at the participant's 10 repetitions maximum weight. The physiotherapist guided the progression regularly by adjusting the participants' ankle weights or elastic resistance bands. Each exercise's end position was held for 5 seconds at first and then progressed to 10 seconds.

Results

The pre-post mean pain and physical function readings for 128 participants (78 females, 50 males) in each exercise interventional strategy were initially analyzed through paired sample t-test at a 95% of Confidence Interval (CI). Data analysis revealed that both exercise strategies turned out to be significantly effective in reducing pain and improving participants' physical function. The 12 weeks of an exercise-based therapeutic program substantially reduces the pain

($p<0.05$) with a mean difference of 2.98 ± 0.07 in Group A and 3.56±0.19 in Group B. In Group A, similar results were reported for physical function while Group B observed more significant improvement with a mean difference of 4.93±4.35 and 2.55±2.33 (Table-1).

Table-1 Within Group (pre-post) analysis of pain and physical function at 95% CI

Groups	n	Variable	Age	Pre	Post	M.D	95% CI	P value
Group A	64	Pain	57±4.03	7.51±0.94	4.53±1.02	2.98 ± 0.07	-5.04 to -4.62	<0.05
		Physical Function		52.74±4.8	45.68±5.5	7.06±0.7	-4.93 to -4.35	
Group B	64	Pain		7.48±0.34	3.92±0.9	3.56±0.19	-2.52 to -2.33	<0.05
		Physical Function		50.51±3.7	42.35±3.02	8.16±0.68	-2.55 to -2.33	

Mean±S.D.
Mean Difference

Mean differences between the two groups were compared for between-group analysis using an independent t-test at 95% CI, keeping a two-tail probability hypothesis curve $p<0.025$ as a significance level for hypothesis testing. After administering the statistical test, the result revealed a meaningful difference in individual subject values (pre-post) and the average values recorded for both groups. A comparison of pain and physical function is depicted in Figure-1.

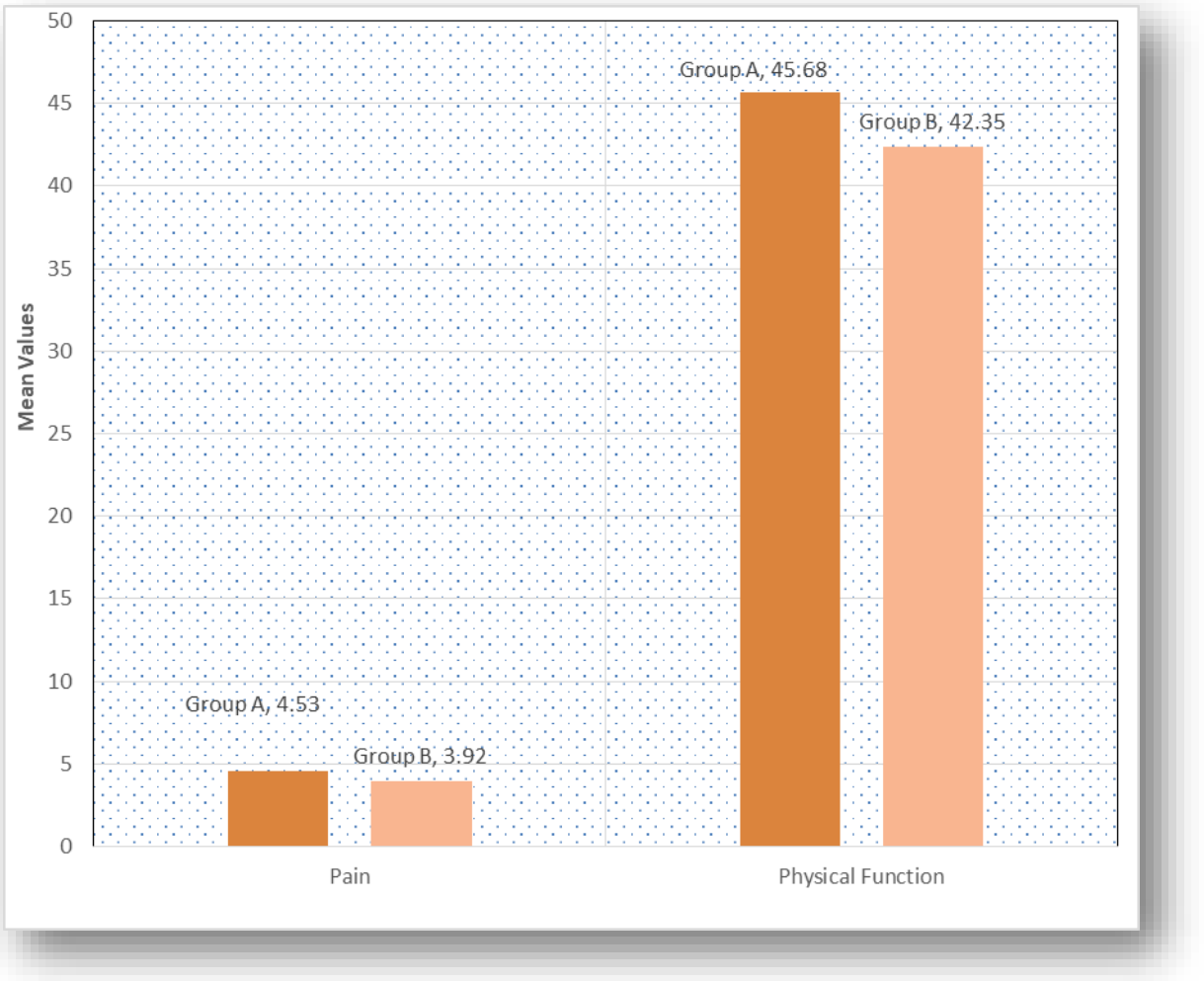

Figure-1 Between group analyses of pain and physical function

Discussion

The results of the study revealed that both groups were found to be effective in improving the outcomes. However, more significant improvement was noted in Group B (non-weight bearing quadriceps strengthening group) with a mean difference of 3.56±0.19 for pain and 8.16±0.68 for physical function in comparison to Group A (Weight bearing functional exercise) with a mean difference of 2.98 ± 0.07 and 7.06±0.7 for both outcomes respectively. While the study found that both types of exercises improved pain and physical function, the non-weight-bearing

quadriceps strengthening group showed more significant improvement compared to the weight-bearing functional exercise group. These findings are supported by a meta-analysis published in 2013 in which aerobic and weight training effects on pain reduction were observed among patients with OA, revealing a more significant effect size of exercises with (a standardized mean difference of -0.94; 95% confidence interval -1.31 to -0.57). The results of subgroup analyses revealed a larger SMD (-1.42 [-2.09 to -0.75]) in non-weight bearing strengthening group as compared to weight-bearing strengthening exercise (-0.70 [-1.05 to -0.35]) and aerobic exercise (-0.45 [-0.77 to -0.13])[13]. Another case study on a 73-year-old patient published in 2020 revealed that most land-based exercises could reduce the symptoms of OA. However, they mostly last for a year maximum as most patients fail to cope with the exercise regime[14]. However, this finding contradicts the belief that weight-bearing exercises are more effective in reducing pain and enhancing function in knee osteoarthritis. Research has shown that aerobic exercise, weight-bearing strength training, and non-weight-bearing strength training have all temporarily relieved knees OA pain, with non-weight-bearing strength training being the most successful[15]. However, it is essential to note that the study was limited to a specific population of patients with knee osteoarthritis and obesity and may not be generalizable to other populations. As reported in the study by Mikesky et al., OA patients were divided into strength training and ROM exercise group for 30 months. The results revealed that strength training decreased the mean rate of joint space narrowing (JSN) in osteoarthritic knees by 26% compared to ROM group[16].

Additionally, it is essential to consider the potential drawbacks of non-weight-bearing exercises. While these exercises may be practical for improving pain and function, they benefit bone health and cardiovascular fitness differently than weight-bearing exercises. The non-weight-bearing exercises may be less functional for patients with milder osteoarthritis or without obesity[17-18]. The finding is particularly noteworthy that non-weight-bearing quadriceps strengthening exercise is more effective in improving pain and physical function than weight-bearing functional exercise. Traditionally, weight-bearing exercises have been recommended for patients with knee osteoarthritis, as they are thought to improve joint stability and increase muscle strength. However, this study challenges this belief and suggests that non-weight-bearing exercises may be a viable alternative[19]. It is important to note that the study has some limitations: The study

only included patients with knee osteoarthritis and obesity, so the results may not be generalizable to other patient populations. The study only followed patients for 12 weeks, so it is unclear whether the observed improvements in pain and function would be sustained over a more extended period. The study did not include a control group, so it is difficult to determine whether the observed improvements were solely due to exercise interventions or other factors. Despite these limitations, the study contributes to the literature on exercise interventions for knee osteoarthritis. The finding that non-weight-bearing quadriceps strengthening exercise may be more effective than weight-bearing functional exercise is particularly relevant, as it provides an alternative option for patients unable to perform weight-bearing exercises. The study highlights the importance of individualized exercise prescriptions, as the type of exercise that is most effective may vary depending on the patient's specific needs and limitations.

Future researches must confirm these findings and explore the effectiveness of non-weight-bearing quadriceps strengthening exercises in other patient populations, such as those with milder osteoarthritis or without obesity. It would also be valuable to investigate the long-term effects of non-weight-bearing exercise interventions on pain and function and other outcomes such as joint structure and quality of life.

Conclusion

It was suggested that non-weight-bearing quadriceps strengthening exercises may be a viable option for decreasing pain and enhancing function in patients with knee OA and obesity. However, it is essential to consider the potential drawbacks and to tailor treatment plans based on individual patient needs and preferences.

Authors Contribution

Khan S: Conception and design.

Islam S: Design and data acquisition.

Ahmed A: Data acquisition and analysis.

Khan R: Data analysis and drafting.

Tasneem S: Revising the draft.

Shahid G: Critical revision and final approval.

Declaration of Interest

None.

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None.

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